AXIAL FLOW FAN

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Japanese Patent Application No. 2002-298843 filed on October 11, 2002.

BACKGROUND OF THE INVENTION

[0002] Electronic components generate heat. In those electronic devices that house a large number of electronic components in a comparatively narrow housing, such as personal computers, LAN servers, copiers, and the like, there is a risk that heat generated by the electronic components will be accumulated inside the housing causing the internal temperature of such devices to rise to unacceptable levels and, thereby, causing the device to malfunction or causing the components within them to fail. Accordingly, ventilation holes are provided, for example, in the wall surface of the housing of such electronic devices and a blower is installed in the ventilation hole to remove heat from the housing. Additionally, blowers may be configured to cool such devices or specific components within them by blowing cool air into such devices.

[0003] The size constraints of the blowers used to remove heat from electronic devices or to cool electronic devices, as well as the airflow and discharge pressure requirements for such blowers are dependent upon the dimensions of the housing in which the blower is mounted, the quantity of heat generated inside the housing, and the density of the electrical components within the housing. Fine adjustments to a blower's output characteristics are sometimes necessary to accommodate the blower's mounting position in the housing, ambient conditions of the environment in which the device with the blower mounted thereon is disposed, or the

needs of specific components in the device. For example, it is sometimes desired to incline slightly the main blowing direction with respect to the axial direction of the blower, or it is sometimes desired to adjust the airflow rate, the air pressure, the blowing sound, or the like.

[0004] The prior art includes fans, such as the fan disclosed in Japanese Patent Application Laid-open No. 10-205497, that include a plate at the fan outlet for changing the amount of the airflow and the direction of the airflow. However, such prior art fans are not capable of making all the necessary fine adjustments and they are not cost effective. Additionally, they are not easily adaptable, making it necessary to store blowers of a variety of types with slightly different specifications.

SUMMARY OF THE INVENTION

[0005] It is therefore an object of the present invention to provide a blower capable of providing all types of the above-described fine adjustment, at a low cost, in an easy and expedient manner in small-scale and low-cost fans. This object is accomplished through the use of flow adjustment devices that are easily attachable to the fan base. A variety of such flow adjustment devices can be manufactured for use with a particular model of fan, thereby, providing a low cost, expedient means of adjusting the airflow for a particular model of fan.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The invention is illustrated by way of example and not limitation and the figures of the accompanying drawings in which like references denote like or corresponding parts, and in which:

[0007] Fig. 1 illustrates a fan according to the first embodiment of the present invention, as viewed from a discharge opening side thereof.

[0008] FIG. 2 shows a section of the fan shown in Fig. 1 along the line connecting points A-O-B.

[0009] FIG. 3 shows a fan according to the first embodiment of the present invention with the casing, motor base, and bearing holder removed.

[0010] FIG. 4 shows a section of the fan shown in Fig. 3 along the line connecting points C-O-D.

[0011] FIG. 5 shows the fixed vane portion of the first embodiment of the present invention removed from the axial flow blower portion of the first embodiment.

[0012] FIG. 6 shows a section of the fan shown in Fig. 5 along the line connecting points E-O-F.

[0013] FIG. 7 is an expanded view of portion (b) shown in FIG. 5.

[0014] FIG. 8 is an expanded view of portion (c) shown in FIG. 6.

[0015] FIG. 9 illustrates the second embodiment of the present invention, as viewed from a discharge opening side thereof.

[0016] FIG. 10 illustrates the operation of the embodiment shown in FIG. 9.

DETAILED DESCRIPTION

[0017] Fig. 1 illustrates an embodiment of an axial fan in accordance with the present invention as viewed from the discharge opening side thereof. FIG. 2 shows a side view cross-section of the fan shown in Fig. 1 corresponding to the line connecting points A-O-B in FIG. 1 in the direction shown by the arrows, this section being open to 180°. The axial fan shown in Figs. 1 and 2 comprises an axial flow blower I and a fixed

vane II, which is one-touch attached in the below-described manner to the discharge opening side (right side in Fig. 2) of the axial flow blower I. Axial flow blower I will be described below with reference to Figs. 1-4. Fixed vane II is a non-rotary vane for adjusting the blowing air rate, air pressure, and blowing sound (noise) in addition to adjustment of blowing direction. The fixed vane II will be described below with reference to Figs. 5 through 8.

[0018] As shown in Figs. 1-4, axial flow blower I is comprised of blower casing 1; round draft hole 1a, which is formed in the central part of blower casing 1; through holes 1b, which are provided in the four corner portions of the casing and which are used to mount the axial fan in an electrical device housing (not shown in the figure); ribs 3, which extend from different positions on the opening edge of draft hole 1a into the central portion of casing 1 on the discharge opening thereof; motor base 4, which is held in place by ribs 3; tubular bearing holder 5, which is fixedly mounted on the central portion of this motor base 4; bearings 6 and bearing 7, which are supported inside bearing holder 5 at a certain distance from each other; rotation shaft 8, which is inserted and supported bearings 6 and 7; C-shaped locking ring 9, which is installed on the distal end of rotation shaft 8 to lock rotation shaft 8 in position in the axial direction; and Impeller 10, which is connected to the rear end of rotation shaft 8 via the boss 10b.

[0019] As shown in Fig. 2, impeller 10 is comprised of impeller body 10c and a plurality of blades 10d. Although only two blades 10d are shown in Fig. 2, this embodiment includes a total five blades 10d, which are provided equidistantly in the rotation direction on the outer periphery of impeller body 10c. Additionally, for the purpose of clarity, impeller blades 10d are not shown in Fig. 1. Impeller body 10c is

comprised of cylindrical part 10a and boss 10b. Impeller 10 is affixed to rotation shaft 8 by boss 10b such that both impeller body 10c and blades 10d are coaxial with rotation shaft 8.

[0020] As shown in Fig. 2, axial flow blower I further comprises direct current motor DCM. Motor DCM is comprised of an almost cylindrical motor yoke 12, which is fitted in and fixedly mounted on the inner periphery of cylindrical portion 10a of impeller 10; cylindrical permanent magnet 13, which is fixed on the inner periphery of motor yoke 12; stator winding 14; stator core 15, which is affixed to the outside of bearing holder 5; and circuit board 16. Circuit board 16 controls electric current to stator winding 14 to generate a magnetic field. The generated magnetic field interacts with permanent magnet 13 to generate a force that causes impeller 10 to rotate.

[0021] Motor base plane portion 4a is formed on the discharge opening side (right side in FIG. 2) of motor base 4 almost as a cylinder around rotation shaft 8 and it is parallel to the plane perpendicular to the axial direction of rotation shaft 8. Through hole 4b, which has a diameter almost equal to the outer diameter of bearing holder 5, is provided in the center of the motor base plane portion 4a. As shown in Fig. 3, three small rectangular holes 4c, which are provided for one-touch attachment of fixed vane II, are provided equidistantly on the outer periphery of motor base plane portion 4a.

[0022] As shown in Fig. 2, the dimensions of rotation shaft 8 are set such that the distal end thereof (end portion on the discharge opening side of the blower) is recessed in the blower from the position of motor base plane portion 4a of motor base 4 and the shaft is formed so that recess 4d is positioned in this portion, matching the opening of through hole 4b. In this embodiment, casing 1, ribs 3, and motor base 4 are

integrally molded from a flexible synthetic resin and the impeller 10 is integrally molded from synthetic resin of the same type. If electric power is supplied to axial flow blower I, impeller 10 rotates counterclockwise, as viewed from the left side (suction opening side) in Fig. 2 and air is blown from the left side to the right side (discharge opening side) as shown by arrow (a) in Fig. 2.

[0023] Fixed vane II will be described with reference to Figs. 1, and Figs. 5 through 8. Fig. 1 shows fixed vane II attached to axial flow blower 1 (blades 10d of axial flow blower I are not shown in FIG. 1 to facilitate understanding). Fig. 5 shows fixed vane II removed from the axial flow blower I. Fig. 6 shows a section along the line connecting points E-O-F in Fig. 5 in the direction shown by the arrows, this section being open to 180°. Fig. 7 is an expanded view of portion (b) surrounded by a dash-dot line in Fig. 5, and Fig. 8 is an expanded view of portion (c) surrounded by a dash-dot line in Fig. 6.

[0024] As shown in Fig. 5 and Fig. 6, fixed vane II comprises vane base 21 and a plurality of radial vane blades 22. Vane base 21 is comprised of vane base plane portion 21a; turned-up wall surface 21b; protrusion 21c; three pairs of projections 21d, where each pair of projections 21d is comprised of two projections having hook-like latches 21e; and three notches 21f. Each radial vane blade 22 includes a base-end portion 22a for connecting the radial vane blade 22 to the turned-up wall surface 21b of vane base 21. Radial vane blades 22 are formed independently from each other and no parts thereof are connected, except that base-end portions 22a are connected to vane base 21, as shown in Fig. 5. The shape, inclination angle with respect to the blowing direction of axial flow blower I (see arrow (a) in Fig. 2), and the number of radial vane

blades 22 are set appropriately according to the required adjustments in the blowing direction, airflow rate, air pressure, generated sound, and the like. The example shown in the figures 5-8 includes eight slightly bent spatula-like radial vane blades 22, each being set so as to be inclined at an angle of about 30° to the blowing direction of axial flow blower I.

[0025] As shown in Fig. 2, vane base plane portion 21a is formed to have an almost cylindrical shape with a diameter slightly larger than that of motor base plane portion 4a. Turned-up wall surface 21b, which protrudes slightly from the circumferential edge of vane base plane portion 21a toward the suction opening side of axial blower 1, is formed so as to cover the side portion of motor base 4. Accordingly, the inner shape of vane base 21 is formed to match the outer shape of motor base 4. The radial vane blades 22 are connected to the turned-up wall surface 21b of vane base 21 and configured to minimize the dimension of fixed vane II along the axial direction of the blower.

[0026] As shown in Figs. 5 and 6, protrusion 21c has a round cross section and it is formed in the central portion of vane base 21. As shown in Fig. 2, protrusion 21c loosely fits into recess 4b. During attachment, protrusion 21c is used for centering fixed vane II in axial flow blower I.

[0027] As shown if Figs. 7 and 8, each pair of projections 21d is comprised of two projections extending from vane base plane portion 21a that are close to each other and that face each other. Additionally, each projection of the two projections that comprise a pair of projections 21d includes a hook-like latch 21e, where the hook-like latches 21e are formed on the non-facing sides of the distal end of the pairs of

projections 21d. As shown in Fig. 2, the three pairs of projections 21d fit into the three small rectangular holes 4c, which are formed in motor base plane portion 4a. However, hook-like latches 21e extend beyond the width of rectangular holes 4c. Additionally, notches 21f are formed in positions corresponding to ribs 3 of fixed vane II in order to prevent ribs 3, which attach motor base 4 to blower casing 1, from hindering the attachment of the fixed vane II to the axial flow blower I

[0028] When fixed vane II is inserted into axial flow blower I, the pairs of projections 21d elastically deform so as to allow the hook-like latches 21e to pass through rectangular holes 4c. After hook-like latches 21e pass through rectangular holes 4c, pairs of projections 21d return to their normal positions and latches 21e engage with the edges of small holes 4c thereby attaching fixed vane II to axial flow blower I.

[0029] One-touch attachment of fixed vane II to axial flow blower I is accomplished by positioning protrusion 21c into recess 4b to center fixed vane II in axial flow blower I; aligning small rectangular holes 4c with projections 21d; and applying a pushing force to fixed vane II. The applied pushing force results in a compressive force being applied by the edges of small rectangular holes 4c to the pairs of projections 21d via latches 21e. The compressive force elastically deforms pairs of projections 21d and allows latches 21e to pass through small rectangular holes 4c. Once pairs of projections 21d have passed through small rectangular holes 4c, the compressive force is removed from pairs of projections 21d and latches 21e engage with the edges of small holes 4c to attach fixed vane II to axial flow blower I. to 21d in the plane portion 4a and vane base plane portion 21a and pushing the vane base plane portion 21a, this

pushing can be conducted in an easy and reliable manner. Thus, one-touch attachment is accomplished by positioning fixed vane II with respect to axial flow blower I and pushing them together.

[0030] The strength and rigidity of the one-touch attachment between fixed vane II and axial flow blower I can be adjusting the materials used in vane base plane portion 21a, pairs of projections 21d, or motor base plane portion 4a and by setting the dimensions of small rectangular holes 4c and pairs of projections 21d. Accordingly, materials and dimensions can be selected such that the one-touch attachment of fixed vane II to axial flow blower I is either detachable or non-detachable. If it is desired to make the one-touch attachment detachable, then it may be desirable to taper the bottom surface of latches 21e.

[0031] If the one-touch attachment is detachable, the fixed vane II can readily be replaced not only prior to product shipping, but also after shipping. Whereas, if the one-touch attachment is non-detachable, the fixed vane II will be very difficult to replace after product shipping, but it will be more reliably and strongly mounted on the axial flow blower I. In the present embodiment, an assumption is made that the desired fixed vane II is selected from a plurality of fixed vanes II of various types prior to shipping, attached to the axial flow blower I, and then shipped. In other words, a single-time attachment is assumed. Therefore, the non-detachable configuration is employed. However, either configuration or an intermediate configuration could be used.

[0032] In the above-described embodiment, the fixed vane II is formed from a flexible synthetic resin of the same type as the material of casing 1, ribs 3, and motor base 4 of axial flow blower I. As a result, the production cost can be reduced.

Furthermore, projections 21d, which are formed in the fixed vane II, can be smoothly engaged with the small holes 4c, which are formed in the motor base 4.

[0033] As shown in Fig. 2, the axial dimension of fixed vane II can be set such that fixed vane II is contained within the axial dimension of flow blower I when fixed vane II is attached to flow blower I. Accordingly, an axial fan having both an axial fan blower I and a fixed vane II according to the an embodiment of the invention can have an axial width identical to an axial fan comprised of only an axial fan blower equivalent to axial fan blower I. As a result, the size of the entire apparatus can be minimized. Additionally, because the axial flow blower I is identical to standard axial flow blowers, except that small holes 4c have been formed therein, it can actually be used as the standard axial flow blower if the fixed vane II is not installed and the small holes 4c may, if necessary, be closed, for example, with tape.

[0034] A second embodiment of an axial flow fan in accordance with the present invention, as viewed from the discharge opening side, is shown in Figs. 9 and 10. In this second embodiment, axial flow blower I is identical to the axial flow blower I used in the first embodiment and fixed vane II is in the form of a louver.

[0035] As shown in Fig. 9, fixed vane II in the second embodiment is comprised of the same components as fixed vane II in the first embodiment, except that in the second embodiment fixed vane II does not include radial vane blades 22 and instead includes straight vane blades 91 and vane base extensions 21g. Vane base extensions 21g extend from turned-up wall surface 21b of vane base 21. Straight vane blades 91 are attached to vane base 21 either on turned-up wall surface 21b or on vane base extensions 21g. Straight vane blades 91 are used for changing the blowing

direction of the air discharged from axial flow blower I. Setting the straight vane blades 91 along the direction inclined with respect to the axial direction of the blower makes it possible to change randomly, for example, up and down or to the left and to the right, the blowing direction of the air discharged from the fan.

[0036] Fig. 10 provides an example of the second embodiment wherein fixed vane II changes the blowing direction from the axial direction (a) to a downward direction (d).

[0037] A third embodiment of the present invention is an order reception and production method whereby a plurality of types of fixed vanes suitable for finely adjusting the main blowing direction, airflow rate, air pressure, blowing sound (generated sound), and the like are prepared in advance; a fan with a desired blowing apparatus is ordered; an axial flow blowing apparatus is assembled by selecting the fixed vane suitable for the desired blowing adjustment and one-touch attaching the selected fixed vane to the discharge opening of the axial flow blower at the time of shipping, and the assembled apparatus is shipped. Accordingly, an axial flow blowing apparatus in which the desired blowing adjustment has been made can be obtained easily and rapidly without producing blowers of different types. Accordingly, such blowing apparatuses can be produced at a very low cost.

[0038] In the above-described first and second embodiments, holes were formed in the motor base and protrusions were formed on the fixed vane. However, the protrusions may be formed in the motor base and the holes may be formed in the fixed vane. In both cases, the fixed vane can be easily and expediently attached to the axial flow blower by employing one-touch attachment using a pressure insertion means

comprising a hole and a protrusion. Further, attachment and detachment of the fixed vane can be conducted in an easy manner. The enumerated claims should be construed to include within their scope all such variations, as well as all other variations or modifications that may be apparent to those skilled in the art.